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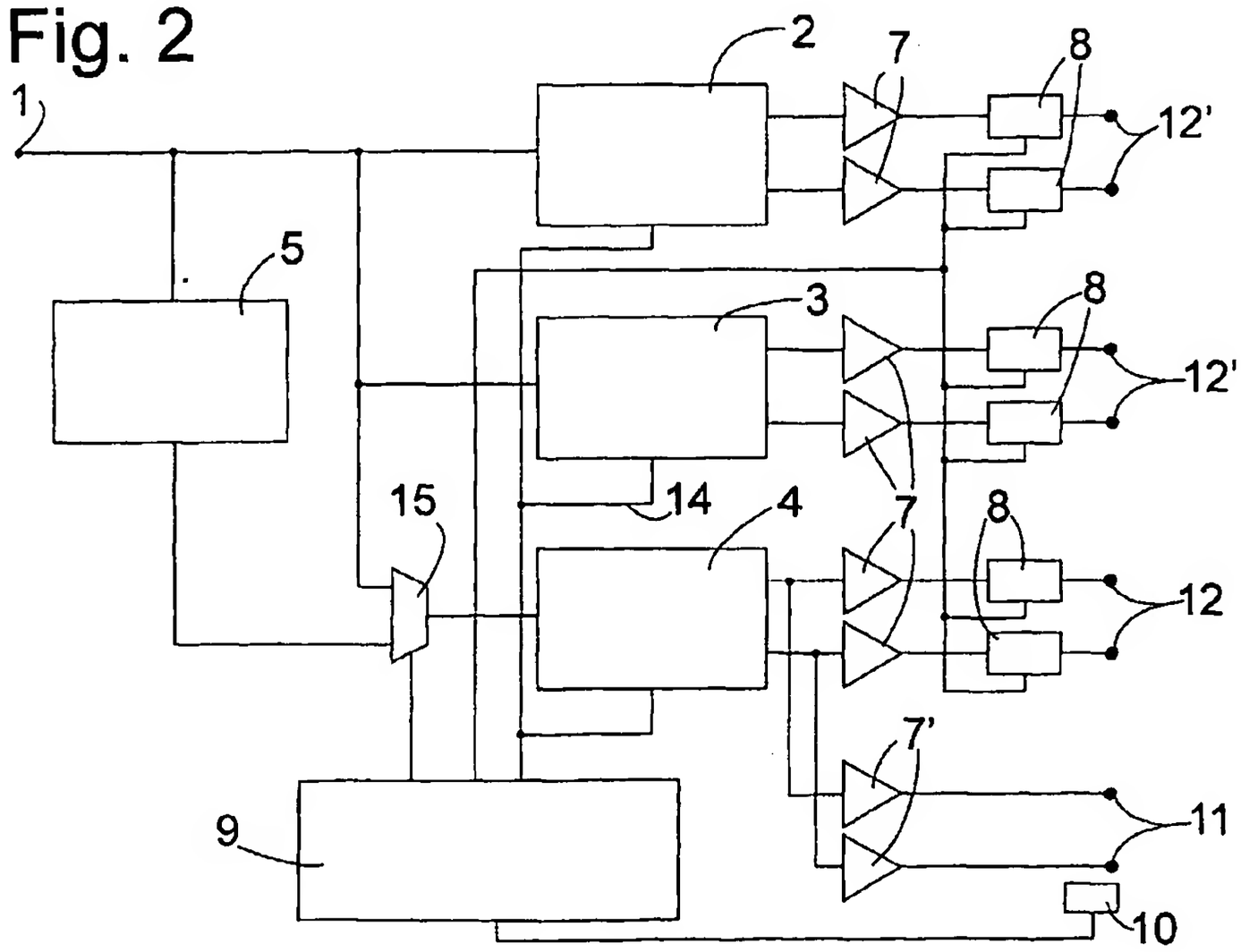
(54) Electronic audio signal processing device

(57) An electronic audio signal processing device comprises

a first DAC (4) for converting a first digital audio signal into an analog signal, first and second output terminals (11, 12) for outputting said analog signal, a detector (10) for detecting whether a sound generating device is connected to the first output terminal (11) or not, a control unit (9) for setting a characteristic of the analog signal to a predetermined value according to whether a sound generating device is detected at the first output terminal (11) or not, and a switch (8) for disabling output of the analog signal by the second output terminal (12) when a sound output device is detected to be connected to the first output terminal (11).

Fig. 2



EP 1 341 394 A1

Description

[0001] The present invention relates to an electronic device for processing a digital audio signal, such as a player/recorder for CD's, DVDs or other types of digital storage media.

[0002] Such an electronic device is known e.g. from JP 8-088 892 A. This prior art device has a digital/analog-converter (DAC) for converting a digital audio signal into an analog signal, first and second output terminals outputting said analog signal to sound generating devices, a detector for detecting whether a sound generating device is connected to the first output terminal or not and a control circuit for setting the power of the analog signal to a predetermined value according to whether a sound generating device is detected at the first output terminal or not.

[0003] If sound generating devices are simultaneously connected to both output terminals, the output power from the DAC is not adequate for the device connected to the second output terminal.

[0004] Accordingly, if a user connects a device to the second output terminal while another is connected to the first, and if this output power is higher than adequate, the resulting noise may startle or even cause pain to the user.

[0005] Conversely, if this output power is lower than adequate, and if the user adapts the volume of sound to his likings while sound generating devices are connected to both output terminals, there is a risk of an excessive volume being output once the second output terminal is disconnected.

[0006] This problem might be avoided if analog signals having different power levels could be supplied simultaneously to both output connectors. There are various ways for doing so, but all have their drawbacks. One is to provide a dedicated DAC for each output terminal. In this way, an excellent quality of sound reproduction is achieved, but this solution is rather expensive and consumes much space on a circuit board. Another is to insert a potentiometer between the output of the single DAC and one of the output terminals. Such a potentiometer must be accessible for setting it, thus imposing constraints on the position of circuit components on a board, a knob for setting it may be necessary, and it is a source of noise. Furthermore, this solution implies the additional cost of the potentiometer.

[0007] The object of the invention is, therefore, to provide an electronic audio signal processing device having two output terminals for connecting different types of sound generating devices, capable of controlling the power of an analog output signal according to whether a sound generating device is connected to one of the output terminals or not, in which there is no risk of an excessive volume being output when a sound generating device has been connected or disconnected, which is inexpensive and achieves a high fidelity of reproduction.

[0008] This object is achieved by an electronic device according to claim 1.

[0009] The analog signal thus generated can be a mono or stereo signal.

[0010] If there are two sound generating devices connected to the two output terminals of this device, the detector will detect the device connected to the first output terminal, preferably the headphone, and the sound generating device connected to the second output terminal, in general the loudspeakers, will be muted by the switch. Thus, it is no longer necessary to disconnect the sound generating device from the second terminal.

[0011] By providing two output terminals for the analog output signal from a single DAC, and setting a characteristic of this analog signal according to the sound generating device detected, the DAC can be put to a double use, and the cost of the device can be reduced relative to a signal processing device requiring a dedicated DAC for each of its output terminals.

[0012] According to a preferred embodiment, the characteristic thus set is the amplitude of the analog signal, i.e. the volume. Alternatively or additionally, also spectral characteristics of the analog signal might be set according to the sound generating device detected.

[0013] Preferably, the first DAC has a reference input for inputting a reference signal, the level of which is to be set by a user, and the amplitude of the analog output signal delivered by the first DAC is proportional to the level of said reference signal. In this way, control of volume is possible directly at the DAC.

[0014] According to a preferred embodiment, the device further comprises at least one second DAC for converting at least one second digital audio signal into an analog signal, a third output terminal for outputting said analog signal, said first and second digital signals forming a set of digital signals for simultaneous reproduction, and the switch is muted to disable output from each third output terminal, too, when a sound generating device is detected to be connected to the first output terminal.

[0015] An electronic device of this type is particularly adapted for processing a so-called Surround signal. Such a signal is composed of up to six individual signal components referred to as Front L, Front R, Center, Subwoofer, Surround L and Surround R, each of which is to be output by one loudspeaker and requires a specific DAC for converting. If one of these DACs is used for generating an analog signal for output by a headphone, the loudspeaker corresponding to this DAC can no longer be supplied with the appropriate signal, so that the set of Surround signal components becomes incomplete. Under these circumstances, generating no sound at all at the loudspeakers is preferable over outputting a "mutilated" Surround signal.

[0016] If the electronic device is for processing a Surround signal one might simply choose a dominant component of this multi-component signal such as the Front L or Front R signals for supplying them to the headphones in appropriately analog-converted form. In order

to increase the fidelity of the headphone signal, it is preferable, however, that the device comprises a digital signal transformation circuit for converting the Surround signal components into a conventional stereo signal and to supply this stereo signal to the first DAC for conversion and to apply the thus converted signal to the headphone.

[0017] Further features and advantages of the invention become apparent from the following description taken in conjunction with the accompanying drawing.

[0018] Figs. 1 to 3 each show a block diagram of an electronic device according to various embodiments of the present invention.

[0019] The device shown in Fig. 1 has an input terminal 1 to which a digital storage device such as a DVD drive, not shown, is connected. From the storage device, the input terminal 1 receives a digital audio Surround signal comprising six digital component signals, namely "Front Left", "Front Right", "Surround Left", "Surround Right", "Center" and "Subwoofer". Three DACs 2, 3, 4 have their inputs connected to the input terminal 1. Each of them receives two components of the input signal, namely "Surround Left", "Surround Right" in case of DAC 2, "Center" and "Subwoofer" in case of DAC 3 and "Front Left" and "Front Right" in case of DAC 4. Each of the DACs 2, 3, 4 has two outputs for outputting an analog-converted signal derived from the two digital component signals it receives.

[0020] The outputs of DAC 4 are connected to a first output terminal 11 via a pair of amplifiers 7', and they are connected to a second output terminal 12 via a pair of amplifiers 7 and a pair of switches 8. The outputs of DACs 2, 3 are connected to third output terminals 12' via a pair of amplifiers 7 and switches 8.

[0021] The state of each switch 8, open or closed, is governed by a control unit 9 according to detection results of a detector 10. This detector 10 is located at a first output terminal 11 for detecting whether a headphone jack (not shown) is inserted in terminal 11 or not.

[0022] If no headphone jack is detected by detector 10, the control unit 9 concludes that there is no headphone connected and holds the switches 8 of DACs 2, 3, 4 closed, so that the amplified output signals of these DACs are present at the second and third output terminals 12, 12', respectively. If a headphone jack is detected, the control unit 9 opens all switches 8, thus disabling the second and third output terminals 12, 12'.

[0023] Each of the DACs 2, 3, 4 has a reference level input for receiving a reference signal defining the output voltage range of the DACs. Reference level inputs of DACs 2, 3, 4 are connected to a same reference level output of control unit 9 via line 14. This line 14 may be a dedicated line on which only the reference signal is transmitted. If so, the reference signal can be an analog signal that is held at a first level by the control unit 9 whenever a headphone jack is detected by detector 10, and is held at a second level when no headphone jack is detected. One or both of these levels can be fixed, can be set by a manufacturer, or, preferably, can be set by a user operating on input means, not shown, of the control unit 9. The levels may be settable independently from one another, so that a listener can arbitrarily assign a value for both of them, or they may be in a certain proportional relationship, so that when the user specifies one of these, the control unit obtains the other by multiplying with a certain factor. The factor is selected such that the volume experienced by a listener using headphones will be approximately the same as the volume experienced when using loudspeakers. Thus, there is no need for a listener to adjust the volume of the device when switching from loudspeakers to a headphone and vice versa. Of course, the factor may also be settable by a user.

[0024] Alternatively, the line 14 may be part of a bus on which control information is exchanged between the control unit 9 and the DACs. In that case the reference signal is digital and can assume two values that can be stored in a memory of control unit 9 and can be fixed or settable as described above.

[0025] In the above embodiment, the analog signal available at the first output terminal comprises the Front Left and Front Right components of the Surround signal.

[0026] A second embodiment is shown in Fig. 2. Components of this embodiment that are identical with those of the first embodiment described above are assigned the same reference numerals and are not described again.

[0027] A digital signal transformation circuit 5 has its input connected to input terminal 1. The transformation circuit 5 receives all component signals of the Surround signal, and it mixes these to form a conventional digital stereo signal referred to as the "Downmix" signal which is supplied to a further DAC 6. The DAC 6 is identical in design to DACs 2, 3, 4. Its two outputs provide a conventional analog stereo signal derived from the "Downmix" signal.

[0028] The outputs of DAC 6 are connected to first inputs of a multiplexer 15. Second inputs of multiplexer 15 receive the "Front Left" and "Front Right" component signals of the digital Surround signal. The multiplexer 15 is controlled by control unit 9 to forward the "Front Left" and "Front Right" component signals to DAC 4 when no headphone jack is detected by detector 10. Under these circumstances, all six component signals of the Surround signal are present at the output terminals 12 and 12'.

[0029] If a headphone jack is detected to be present at the first output terminal 11, the digital stereo signal from signal transformation circuit 5 is forwarded to DAC 4. In this case, the output terminals 12, 12' are all disabled by switches 8, and an analog-converted conventional stereo signal is present at the first output terminal 11.

[0030] A third embodiment of the invention is shown in Fig. 3. It comprises all components of the second embodiment and, in addition, a further DAC 6 connected to

the output of signal transformation circuit 5 and supplying a conventional analog stereo signal to a fourth output terminal 13 via amplifiers 7 and switches 8'. These switches 8' may be controloled by control unit 9 in the same way as switches 8 of the first and second terminals 12, 12' or independently from these.

Claims

1. An electronic device comprising

   a first DAC (4) for converting a first digital audio signal into an analog signal,
   first and second output terminals (11, 12) for outputting said analog signal,
   a detector (10) for detecting whether a sound generating device is connected to the first output terminal (11) or not,
   a control unit (9) for setting a characteristic of the analog signal to one of two predetermined values according to whether a sound generating device is detected at the first output terminal (11) or not,

   characterized in that the device further comprises a switch (8) for disabling output of the analog signal by the second output terminal (12) when a sound output device is detected to be connected to the first output terminal (11).

2. An electronic device according to claim 1, wherein the first output terminal (11) is a headphone output terminal and wherein the second output terminal (12) is a loudspeaker output terminal.

3. An electronic device according to claim 1 or 2, wherein the characteristic is the power or the amplitude of the analog output signal.

4. An electronic device according to one of the preceding claims, wherein the first DAC (4) has a reference input for receiving a reference signal from the control unit (9), the reference signal being capable of assuming one of two values according to whether a sound output device is detected to be connected to the first output terminal (11) or not, and wherein the characteristic of the analog output signal delivered by the first DAC (4) is proportional to the level of said reference signal.

5. An electronic device according to claim 4, wherein at least one of said two values of the reference signal is user-settable.

6. An electronic device according to one of the preceding claims, comprising at least one second DAC (2, 3) for converting a second digital audio signal into an analog signal, a third output terminal (12') for outputting each of said analog signals, said first and second digital signals forming a set of digital signals for simultaneous reproduction, wherein the switch (8) is adapted to disable output from said third output terminal (12') when a sound generating device is detected to be connected to the first output terminal (11)

7. An electronic device according to claim 6, wherein the set of digital signals is a Surround signal.

8. An electronic device according to claim 6 or 7, comprising a digital signal transformation circuit (5) for mixing said second digital signal to said first digital signal supplied to said first DAC (4) when a sound output device is detected to be connected to the first output terminal (11).

Fig. 1

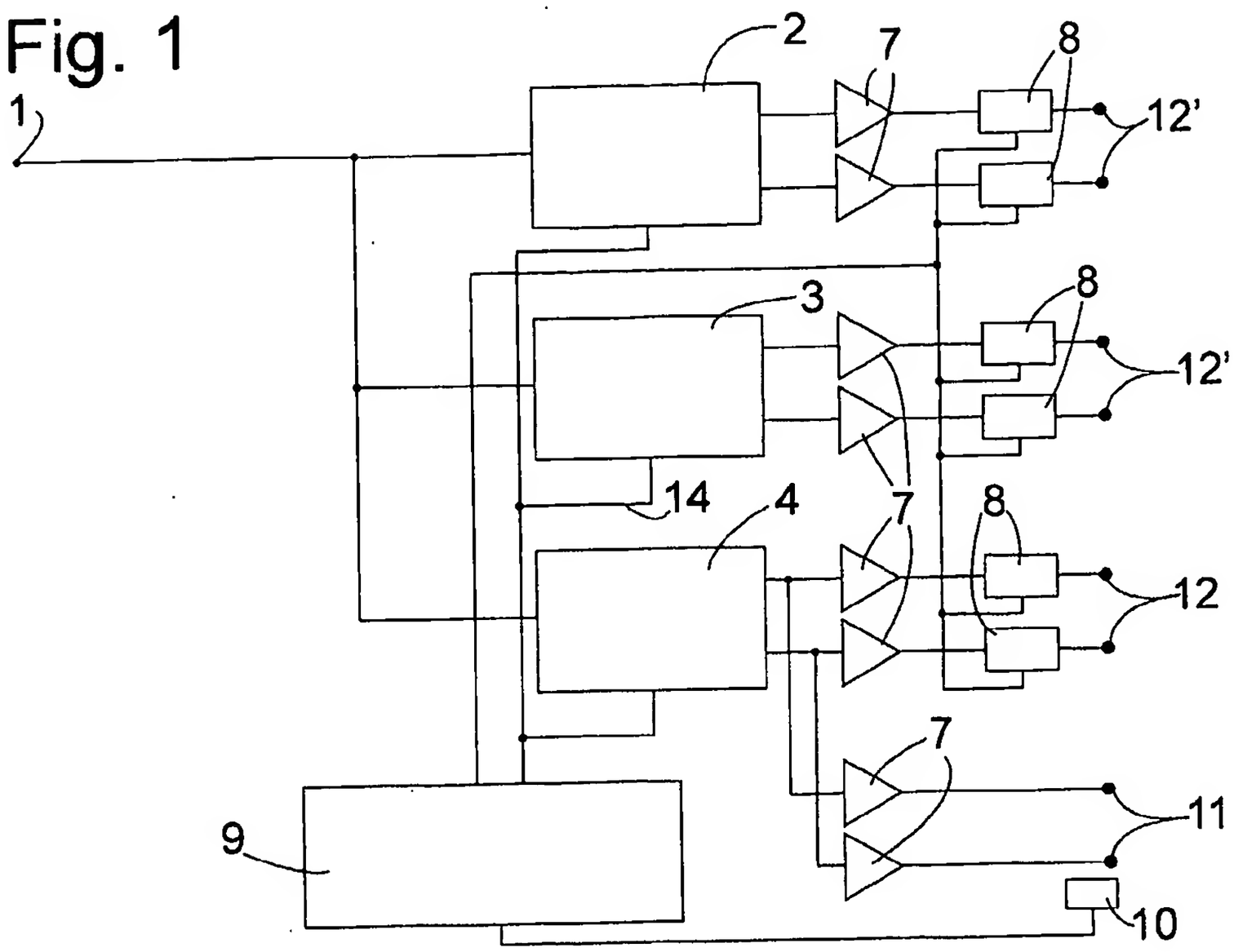


Fig. 2

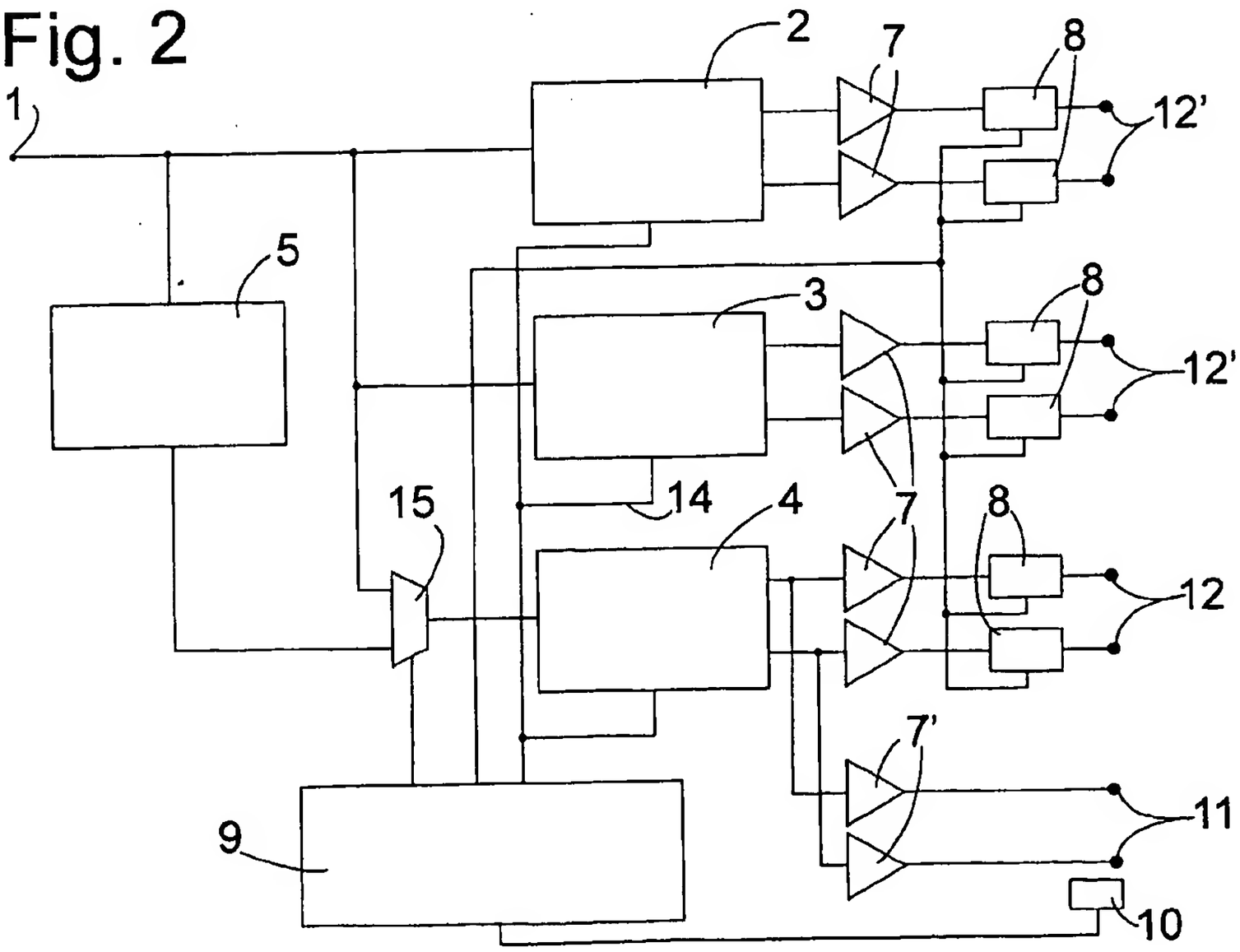
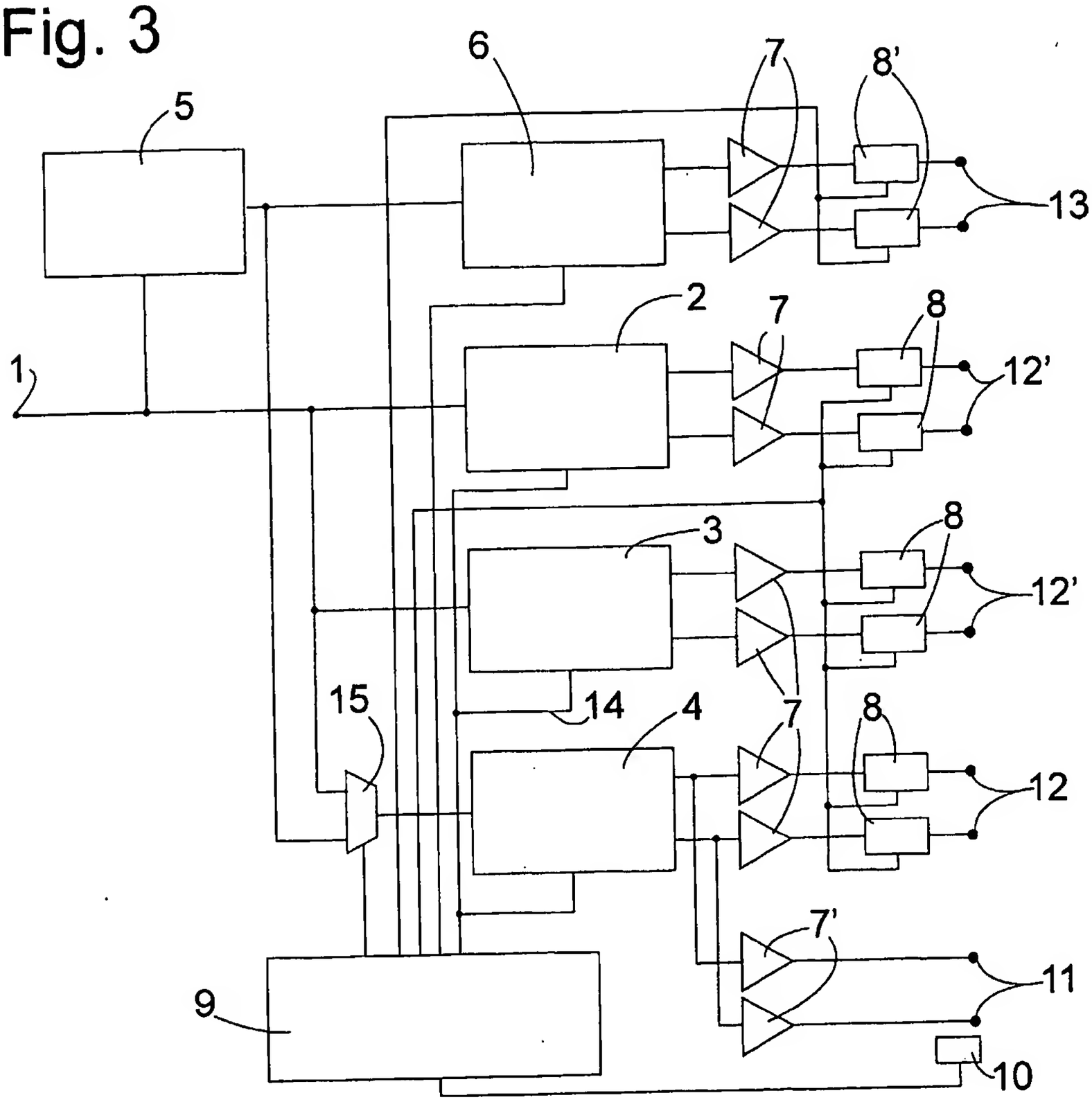


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 02 29 0472

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A,D	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 08, 30 August 1996 (1996-08-30) & JP 08 088892 A (SONY CORP), 2 April 1996 (1996-04-02) * abstract * ---	1-7	H04R3/00 H04S3/00
A	EP 0 659 029 A (GRUNDIG EMV) 21 June 1995 (1995-06-21) * column 3, line 40 - column 4, line 23; figures * ---	1-7	
A	US 5 161 198 A (NOBLE SCOTT W) 3 November 1992 (1992-11-03) * column 1, line 62 - column 2, line 14; figures * ---	1-7	
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 11, 30 September 1999 (1999-09-30) & JP 11 162574 A (CANON INC), 18 June 1999 (1999-06-18) * abstract * -----	1-7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H04R
H04S

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 December 2002	Gastaldi, G

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